COMMENTS ON THE BIOGEOGRAPHY OF ARABIA WITH PARTICULAR REFERENCE TO BIRDS

BY

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(With two maps)

During World War II my interest became aroused in southern Arabia, when I had occasion to fly over it several times on military business and to land at various hitherto inaccessible places, such as Sharjah and Dhahran. Although the mountains of Yemen in the south-west have been visited by naturalists, notably a British Museum of Natural History expedition in 1937 (Scott, 1942), virtually nothing is known of the fauna of Muscat and Oman, and of the spectacular so-called 'Green' Mountains, the Jabal al Akhdhar, which rise to a height of over 10,000 ft.

In 1950 I had an opportunity to visit Arabia and Muscat, but was prevented by a changed schedule from actually visiting the south-eastern corner of the Peninsula. However, as a result of that visit and of my correspondence with the Sultan of Muscat, three years later a joint collecting expedition, sponsored by the Philadelphia Academy of Natural Sciences and Yale's Peabody Museum (de Schauensee and Ripley, 1953) was arranged. The collection made on this expedition has added considerably to our knowledge of the avifauna of the area, and has prompted me to prepare the following comments.

Little can be understood of the history of the fauna of Arabia without an attempt to picture the geological events which have produced the conditions perceived today. The following brief summary of the recent geology of Arabia, therefore, seems appropriate.

GEOLOGY

The Peninsula of Arabia is a vast peneplain, bordered at its western, south-western, and south-eastern extremities by two blocks of highlands composed of a core of ancient crystalline rocks on which have been superimposed huge thicknesses of successive formations, mainly sandstones, during the Cretaceous.

In late Cretaceous or early Cenozoic time, western Arabia was uplifted far above sea level and a period of faulting and crustal movements set in. At this time western Arabia was connected to Africa, which, during a large part of this period, was isolated from the rest of the world. This unity remained until early Miocene time. Vulcanism developed and has continued to the present as evidenced by hot springs and vapor fissures. There are many lava outcroppings in the western Arabian highlands. The tableland of Yemen is an enormous upraised block of lower Cenozoic or Tertiary age with central peaks rising to 10,000 ft. above sea level.

Eastern Arabia was submerged in Miocene time, emerging before the end of this period, covered with Eocene sediments. According to Gregory (1929) the Oman Mountains are related to the Zagros mountain system. He feels there is no evidence for considerable submergence in south-western Iran, or a broad separation between Eurasia and Arabia by intervening seas. On the contrary there seems to be no certain evidence for a land connection during this period across the Persian Gulf. Certainly the northern part of the Gulf is post-Pliocene (*vide* Gregory, 1929: 118).

Meanwhile before the end of the Miocene, the time of the worldwide spread of savannah vegetation types still characteristic of parts of eastern Africa, the Red Sea was flooded from the north by the Mediterranean, but Arabia remained connected to Africa through Yemen-Somaliland (Furon, 1941). This latter connection was broken in late Pliocene and meanwhile a Sinai connection had arisen which has continued in roughly the same shape to the present day era of the Suez Canal.

The above brief summary of geological events prior to the Pleistocene is given to indicate only that there had been land connections between Arabia and the adjacent continents as far back as the origin of the Peninsula, but that these connections were not always contemporaneous, and that the mountains of the south-western parts of Arabia in Yemen and of the south-eastern in Oman respectively, are neither contemporary nor apparently closely related.

Pleistocene

Superimposed on these earlier rocks are alluvial and aeolian deposits of Pleistocene date. The Pleistocene is noted, of course, for its glaciation in the temperate zones of the world, as well as for a certain amount of transitory glaciation in the higher montane equatorial areas. Flint (1947: 468) describes conditions in the northern hemisphere which tended to produce the so-called pluvial periods in the tropical latitudes:

> 'With the gradual growth of ice sheets in North America, Siberia, and Europe and with the growth of sea ice in the Arctic Sea and the North Atlantic, high-pressure conditions were established in the air over them, and the entire belt of eastward-moving cyclonic storms ('the belt of westerlies') was shifted progressively southward. In South America a similar northward shift took place, but it was certainly less pronounced because the area of glacier ice in southern South America was comparatively small.
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> 'As the belt of cyclonic storms edged southward, regions—especially in the extra-tropical belts of high pressure—that are dry under the climates of today began to experience increased rainfall. At the same time the increased cloudiness that characterizes the belt of westerlies operated to reduce the evaporation rate, already diminished somewhat by the worldwide cooling that had preceded the growth of the ice sheets. The results were increased stream discharge, expansion of existing lakes without outlets, and the

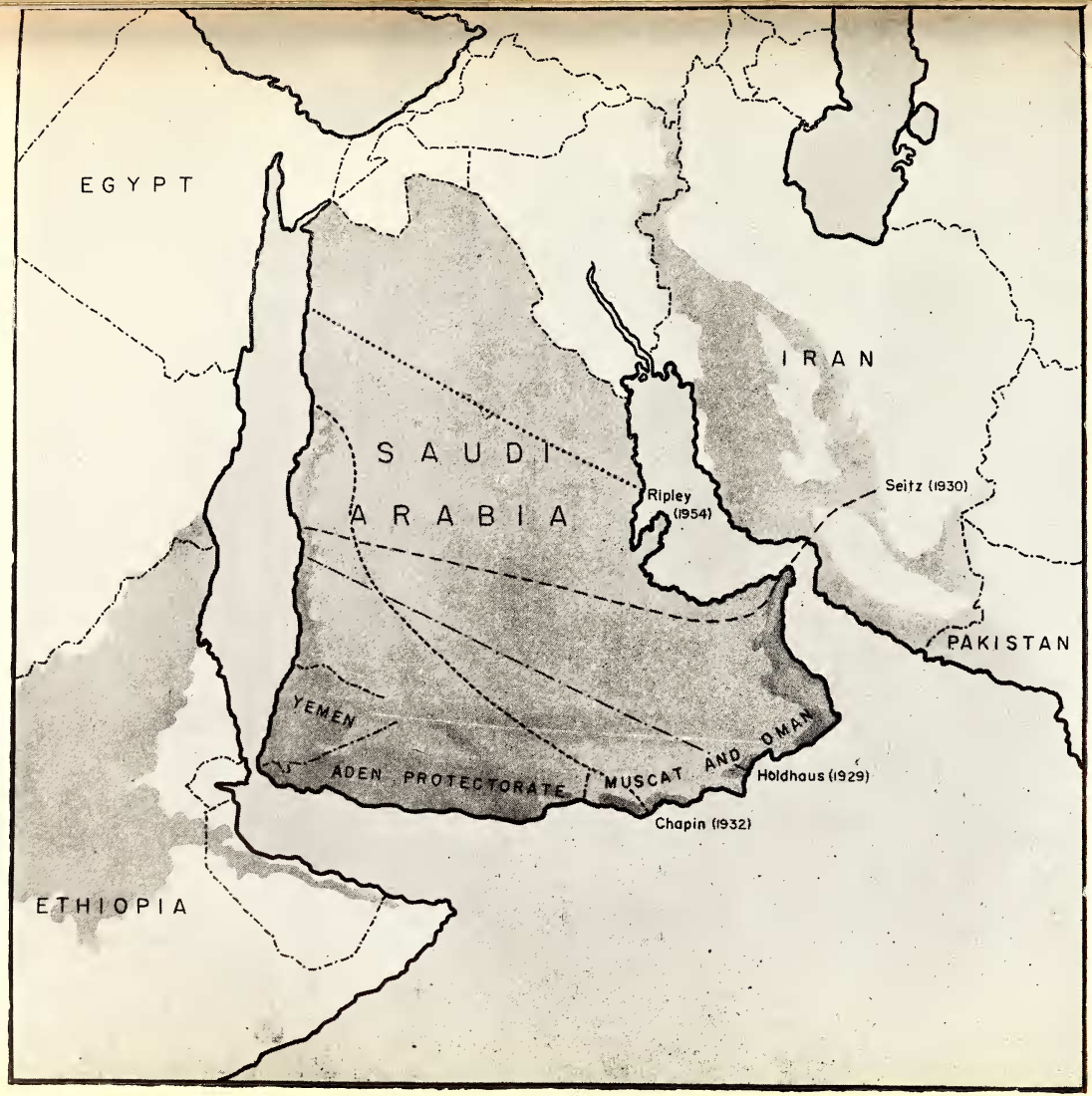

Figure 1. Map of Arabia showing highlands (shaded areas), and proposed lines of demarcation between the Palaearctic Zone, and the more southern types or districts, as proposed by various authors, cited in the text.

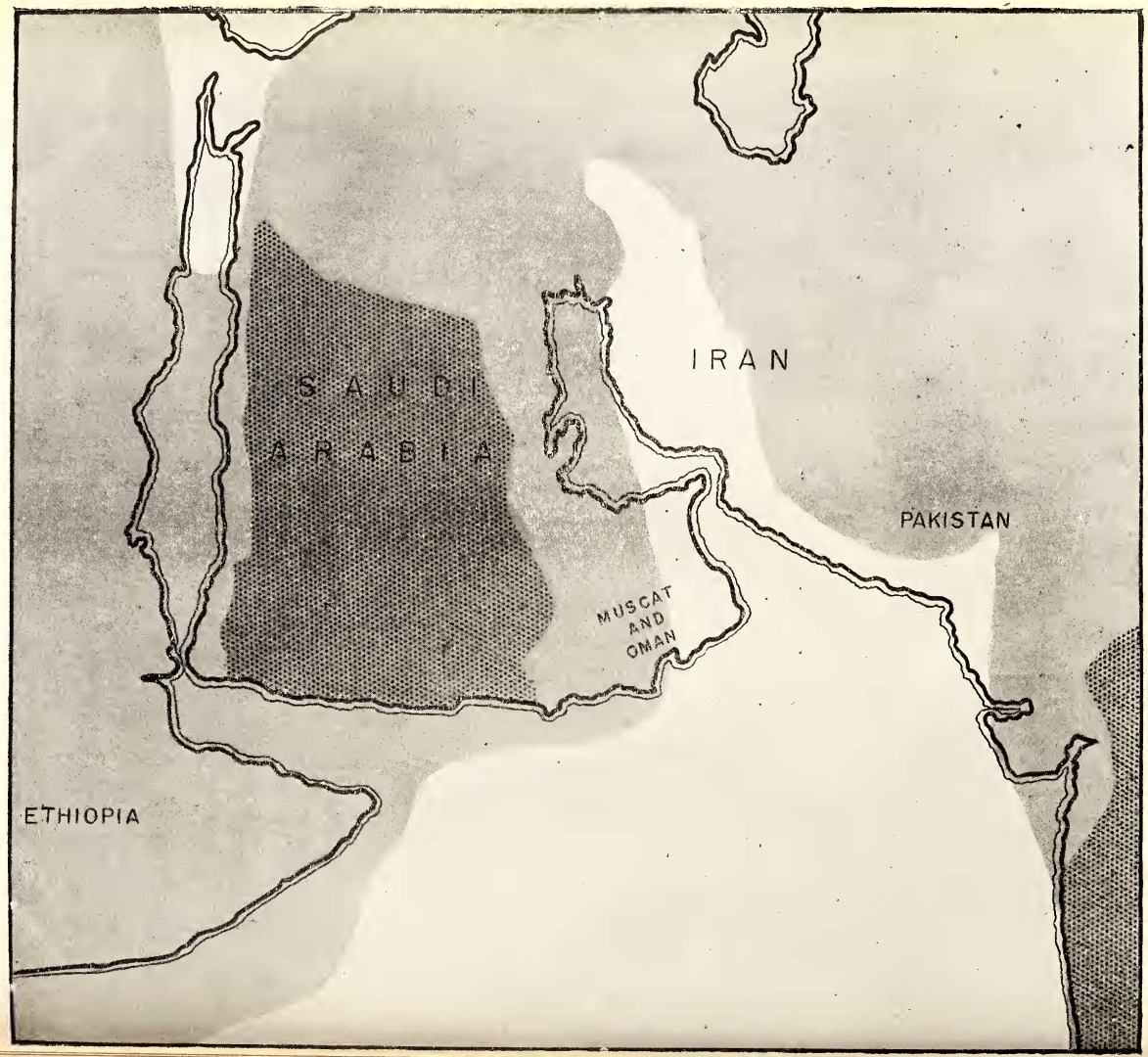

Figure 2. Arabia as it might have appeared in early Miocene time, (adapted from Gregory). Shaded area represents dry land, the stippled areas, 'Arabian Upland Basin', and 'Gondwana' respectively.

creation of lakes in basins previously dry. In short, a pluvial age came into being.

'In the Old World, in like manner, pluvial conditions affected chiefly the Mediterranean lands, northern and central Africa, Asia Minor, central Asia and northern China. However, the effects were felt right down to the equator itself, where evidence of expanded lakes in East Africa is clear and extensive. This fact is not as surprising as it seems at first. The northern half of Africa is the only large subtropical land mass lying north of the equator. Because of this vast expanse of land it is more favourably situated than any other subtropical region to receive winter-season outbreaks of cold polar air. Even today these outbreaks reach as far south as latitude 15°. During the glacial epoch these outbreaks should have reached the equator itself.'

During these pluvial periods it has been assumed that the average temperatures fell several degrees [how much for the equatorial belt is uncertain and equivocal (Moreau, 1933, 1952)], but at 20°N. latitude there is little doubt that it would be a significant figure. Even a relatively small change in temperature plus increased precipitation would be enough to alter the climate sufficiently to extend the savannah and arid vegetation types north along the western Arabian coast to Sinai and Egypt, and on the east from Trucial Oman to Iran, thus making a continuous belt of light forest and grassland in the form of a connecting link between Arabia and the continents.

Huzayyin (1941) who has worked in Yemen reports evidences of two major pluvial periods which he equates with the Kamasian and Gamblian in East Africa, with an interpluvial stage characterized by vulcanism as also found in Africa. Zeuner (1950) states that both these pluvials are contemporary with a Levalloisian variety of the Paleolithic. Other remains of prehistoric man are still rare in the literature for Arabia. Blades, burins, and end scrapers of Levalloisio-Mousterian type have been found at Turaif near the Jordan border, and Mousterian implements at Badanah near Iraq, both of the last interglacial or the beginning of the last glacial period in date (Coon, personal communication).

Caton-Thompson and Gardner (1939) report paleoliths of a crude Levalloisian type from the Hadhramaut indicating in their opinion a low ebb in paleolithic culture, perhaps due to the impoverished and harsh environment, also indicating a degree of isolation from the nearby cultures of Africa, North Arabia, and Palestine. Such evidence as there is, then, would indicate that pluvial conditions during the Pleistocene were enough only to ameliorate, not to change radically, the rather arid biota of Arabia. Savannah grassland and thorn scrub could have existed over large parts of the Peninsula, especially outlining the shore lines and montane features, where only desert exists today. That in itself would have been sufficient to encourage the spread of animals, plants, and associated man.

Pleistocene—Recent

There are some scraps of evidence for a more recent wet phase. Huzayyin (1941) proposes that this wet phase may have continued as late as 1600 years ago, basing his theory largely on archaeological

data. Philby (1933) found gravel spread on the north side of the Rub-al-Khali (possibly lacustrine) and stone artifacts of neolithic facies. This might be correlated with the 'Neolithic' wet phase found in Egypt at Fayoum and Kharga, and 'Pluvial C' in Palestine. In the Sudan Red Sea Hills there is some evidence for a wet phase about 10,000 to 15,000 years ago based on the semi-fossil Mollusca found there. Many other evidences point to the existence of a so-called Mesolithic rainy interlude (Murray, 1951) in Egypt, Libya, and the Sudan, dating as late as 4000 B.C. and extending back at least to 8000 B.C. This date would be satisfactory when compared with the recent radiocarbon datings of about 10,000 years ago for the Mankato maximum of Wisconsin, preceded by a warmer period about 11,400 years ago (Allerod horizon-Two Creeks) in Western Europe and North America (Flint and Deevey, 1951, Flint, 1953).

Dessication certainly began in Africa about 6,000 years ago and has continued to the present with little change. In Nubia there has been no continuous rainfall since about 5,500 years ago. Wood-Jones (1907-1908) reported the preservation of later predynastic bodies of that time, which were buried in the sand, as so complete that even eyes and brains are preserved, shrunken but intact. Gradually the scrub forests and the grasslands have disappeared. Stumps of trees lie on the Libyan desert where they have not grown for 5,000 years. Similar vestiges occur near Taif in western Arabia. Networks of trails of grazing animals cover hillsides where the vegetation disappeared in early predynastic times. Flake industries existed on hills in eastern Egypt which have not supported populations for millenia. The rise of the climatic optimum or thermal maximum in Europe which has been dated from about 6,000 to 3,000 years ago (Flint and Deevey, 1951) sounded the knell of the sparse savannah and steppeland growth of the lowlands of Arabia which thereby began their long progress towards the desert conditions of today. In spite of these minor changes, there is no indication whatsoever that the climate of this part of the world has undergone any radical alterations since the commencement of the Pleistocene.

Climate Today

Today rainfall in Arabia as a whole is insignificant. In the Yemen highlands it may reach 14 to 15 inches annually, mostly during the summer monsoon. In these highlands there are perennial streams and springs, although no streams reach the coast or far into the interior, losing themselves in their older, greater courses in the sand.

In the adjacent lowlands rainfall is no more than $2\frac{1}{2}$ inches per annum, with interior areas of the Peninsula having less. Isolated from the south-western hills (although the southern coastal belt of the Dhofar receives moisture in the form of a cloud and mist cover and heavy dews from the sea) are the south-western Oman hills. Rainfall may reach 4 inches in the coastal area, concentrated during December and January. Figures are not available for the Green Mountains of Muscat which have a parallel rainy season, and an intermittent cloud cover as well with a mist blanket of moisture in lieu of rain. In

February each year, crop of fine grasses springs up on the plateaux at 6,000 ft. which is grazed by feral asses. There are no perennial streams in Oman.

The principal vegetation of Arabia is xerophytic, the habitats ranging from open desert sand to rocky cliffs, to arid steppe highlands dotted with occasional grasses or shrubs, many of them succulent, to patches of tropical grassland savannah. On the heights cultivation occurs with olives, figs, citrus trees, grains, wheat, barley, 'dhurra' or sorghum, millet, lucerne, and coffee above 5,000 feet. These isolated highlands in the south-west and south-east serve as 'islands,' 'refugia,' for relict, Palearctic plants—primulas, iris, potentillas, and such genera as *Juniperus*, *Monotheca*, and *Caylusea*.

Among birds there are important Palearctic relict forms in Yemen such as the Hedge-Sparrow, the Bullfinch, the Wheatear, Gray Shrike, and the Serin Finch. There are Palearctic relict reptiles and numerous insects, all presumably dating from pluvial times. Among the mammals, however, none can be ascribed to the Palearctic with the possible exception of the hedgehog, the rest being derived either from Africa or the Orient.

Origin of the Avifauna

With the exception of the species enumerated above, the birds which are known to be resident today in southern Arabia can be shown to have been derived either from the Ethiopian region or the Indian sub-region. These are entirely arid country forms of life. Such species may have derived from savannah types, but endemism is very high in what Chapin (1932) calls the 'Somali Arid' sub-region.

Attempting to screen out only the resident land birds, and to eliminate those species of presumed Palearctic origin, a rough listing of the two areas gives the following:

	SW. Arabia	*SE. Arabia*
No. of families (including ostrich)	22	... 12
No. of species	36	... 16
Ethiopian derived	23 = 64%	... 0
Indian or Ethiopian	6 = 17%	... 3 = 20%
Indian or Mid-Eastern	7 = 19%	... 13 = 80%

The above figures include endemic species and subspecies. The latter are fairly easy to ascribe, as often they belong to species found either in the Ethiopian region or the Indian sub-region, although the latter category may include south-east European elements. Some forms such as the local resident bee-eaters and larks might be assigned to either fauna, and have been listed under the category 'Indian or Ethiopian'.

Moreau (1952: 905) states that, 'The status of the Somali . . . arid avifauna suggests . . . uninterrupted local evolution since the Pliocene, and perhaps since the Miocene. It follows that none of the Pleistocene pluvials (and no consequences of the movement in the caloric equator) can have extinguished at any time the arid environment in the areas concerned.'

Analyzing the avifauna possessed in common by Africa and the Indo-Malayan region, Moreau (1952) shows that the affinities between the two areas in birds are mostly at the family or ordinal level indicating a very long separation climatically, thus fitting with the hypothesis that free interchange of evergreen forest organisms could not have continued more recently than early Pliocene time.

The above statements are interesting as supporting the evidence derived from the fauna of Arabia, that the Peninsula has been a segment of a faunal barrier for a considerable time.

Looking also at the figures presented above it is interesting to note the degree of difference between the avifaunas of south-west and south-east Arabia. While the south-west area [included by Chapin (1932) in the 'Somali Arid'] has a clear majority of forms derived from the Ethiopian region, either similar subspecies or closely related forms, the south-east has no clear-cut cases, and only 20 per cent belonging to the category 'Indian or Ethiopian'. It is of course entirely possible that further collecting in south-east Arabia will reveal more resident forms.

In addition it is noteworthy that there are forms representing 19 per cent of the total in south-west Arabia which can clearly be ascribed to Indian or Middle-East sources, while this figure reaches 80 per cent in south-east Arabia. Therefore, it would appear that in southern Arabia, the intervening country between the Yemen and Muscat highlands forms in itself a substantial barrier to faunal interchange; supported by the fact that several bird genera such as *Turdoides*, *Ammomanes*, *Alectoris*, *Prinia*, etc. have subspecies differing from each other in the two areas. Additionally the barriers between southern Arabia and neighbouring biotic types have been strong enough to create a distinct group of residents, rather different in composition. As an example of this, in the Oman-Muscat area several Indian birds occur which have been able to penetrate no farther west than these hills. Five of these species, the Redwattled Lapwing, Senegal Dove, Indian Parakeet, House Crow, and Malabar Munia cannot be separated taxonomically from their Indian relatives.

Of the endemic birds found in southern Arabia only two are specifically distinct. One, the Blackheaded or Yemen Partridge, *Alectoris melanocephala*, seems most closely related to the Chukor Partridge of India and the Middle-East. The second species, the Taif Woodpecker, *Picoïdes dorae*, seems Asian in origin to me, closest to the Indian relict species *Picoïdes mahrattensis* and its only close relation, *P. auriceps*, of the Himalayas. *Dorae* resembles these species in its reduced and browned-out but similar patterns on the nape, lower abdomen and vent, under tail-coverts, and on the wings and tail.

Interestingly enough the sole Arabian mammal species is a similar 'relict' related to the Himalayas area, the Tahr, *Hemitragus*.

Limit of the Palearctic in Arabia

Seitz (1930; in Warnecke, 1933) says that the southern limit of the Palearctic in Arabia lies north of a line between Mecca and the northern end of the Gulf of Oman. Holdhaus (1929) makes the line a little more to the south along the 20th parallel, thus excluding Oman